

10/534863

(TRANSLATION)

Our Ref.: 123895

FOR IDS:

Comments provided by Toyota on  
the following Prior Art References

JP 09-256886:

With the apparatus of this prior art, an inner pressure of the cylinder is calculated, and a fuel injection ratio is calculated from a differential pressure between this calculated inner pressure of the cylinder and a pressure of the fuel supplied to the injector. Then, a conduction time of the injector is calculated from a required fuel injection quantity and the calculated fuel injection ratio.

**Comments:**

This prior art fails to reproduce the phenomenon wherein the fuel injection quantity becomes somewhat a larger quantity in injection of a small quantity of fuel, and the fuel injection quantity becomes somewhat a smaller quantity in injection of a large quantity of fuel, by an inner pressure of the cylinder.

With this prior art, when a rail pressure is low, an error becomes larger.

JP 2000-54889A:

With the apparatus of this prior art, an inner pressure of the cylinder is actually measured, and correction thereof is performed. Then, the fuel injection time, the igniting time and the like are controlled based on the inner pressure of the cylinder.

LAST ITEM

# EUROPEAN PATENT OFFICE

## **Patent Abstracts of Japan**

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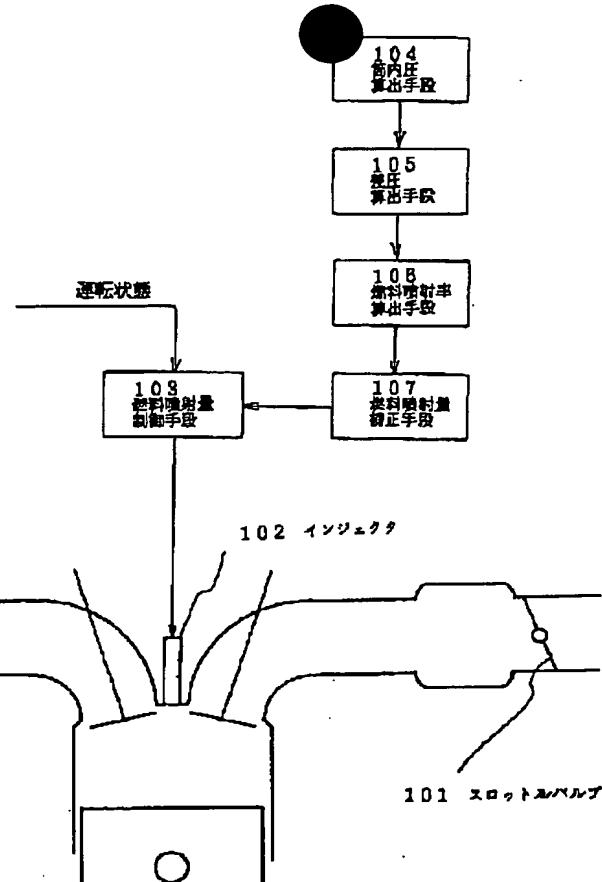
APPLICATION DATE : 25-03-96  
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APPLICANT : NISSAN MOTOR CO LTD;

INVENTOR : YASUOKA MASAYUKI;

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**TITLE : FUEL INJECTION CONTROLLER FOR  
DIRECT INJECTION TYPE ENGINE**



**ABSTRACT :** PROBLEM TO BE SOLVED: To precisely control a fuel injection quantity by computing a differential pressure between a cylinder internal pressure computed according to an operating condition and a fuel pressure supplied to an injector, computing a fuel injection rate on the basis of the differential pressure, and correcting a valve opening time of the injector on the basis of the fuel injection rate.

**SOLUTION:** In a direct injection type engine provided with a throttle valve 101 throttling an intake passage in compliance with an operating condition and an injector 102 injecting fuel into a cylinder, a valve opening time of the injector 102 is controlled by means of a fuel injection quantity controlling means 103 according to the operating condition. The direct injection type engine is also provided with a cylinder internal pressure computing means 104, which computes a pressure inside the cylinder according to the operating condition, and a differential pressure between the computed cylinder internal pressure and a fuel pressure fed to the injector 102 is computed by means of the differential pressure computing means 105. On the basis of the computed differential pressure, a fuel injection rate is computed by means of a fuel injection rate computing means 106, and then, a valve opening time of the injector 102 is corrected by means of a fuel injection quantity correcting means 107 on the basis of the fuel injection rate.

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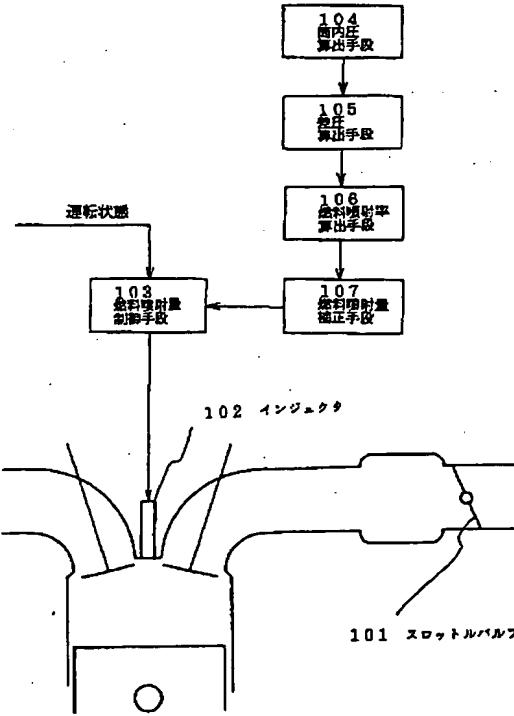
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(54)【発明の名称】 直噴式エンジンの燃料噴射制御装置

(57)【要約】

【課題】 直噴式エンジンの燃料噴射制御装置において、筒内圧センサを用いることなく、燃料噴射量を正確に制御する。

【解決手段】 検出された運転状態に応じて筒内の圧力  $P_c$  を算出する筒内圧算出手段104と、算出された筒内圧  $P_c$  とインジェクタ101に供給される燃料圧力との差圧  $P_f$  を算出する差圧算出手段105と、算出された差圧  $P_f$  を基に燃料噴射率  $K$  を算出する燃料噴射率算出手段106と、算出された燃料噴射率  $K$  を基にインジェクタ101の開弁時間  $T_i$  を補正する燃料噴射量補正手段107とを備える。



## 【特許請求の範囲】

【請求項1】吸気通路を運転条件に応じて絞るスロットルバルブと、  
筒内に燃料を噴射するインジェクタと、  
検出された運転状態に応じてインジェクタの開弁時間 $T_i$ を制御する燃料噴射量制御手段と、  
を備える直噴式エンジンの燃料噴射制御装置において、  
検出された運転状態に応じて筒内の圧力 $P_c$ を算出する  
筒内圧算出手段と、  
算出された筒内圧 $P_c$ とインジェクタに供給される燃料  
圧力との差圧 $P_f$ を算出する差圧算出手段と、  
算出された差圧 $P_f$ を基に燃料噴射率 $K$ を算出する燃料  
噴射率算出手段と、  
算出された燃料噴射率 $K$ を基にインジェクタの開弁時間  
 $T_i$ を補正する燃料噴射量補正手段と、  
を備えたことを特徴とする直噴式エンジンの燃料噴射制  
御装置。

【請求項2】 クランク角を検出するクランク角検出手段と、

換出されたクランク角とスロットルバルブより下流側に生じる吸気管負圧に応じて筒内の圧力  $P_c$  を算出する筒内圧算出手段と、  
を備えたことを特徴とする請求項 1 に記載の直噴式エンジンの燃料噴射制御装置。

【請求項3】吸入空気量を検出する吸入空気量検出手段と、

吸気管の最小流路面積を検出する最小流路面積検出手段と、  
検出された吸入空気量と最小流路面積に応じてスロットルバルブより下流側に生じる吸気管負圧を算出する吸入負圧算出手段と、  
を備えたことを特徴とする請求項2に記載の直噴式エンジンの燃料噴射制御装置。

【請求項4】エンジン回転速度から燃料噴射時期を決定する燃料噴射時期決定手段と、  
決定された燃料噴射時期とスロットルバルブより下流側に生じる吸気管負圧に応じて筒内の圧力 $P_c$ を算出する筒内圧算出手段と、  
を備えたことを特徴とする請求項1から3のいずれか一つに記載の直噴式エンジンの燃料噴射制御装置、

## 【発明の詳細な説明】

【発明の属する技術分野】本発明は、直噴式エンジンの

## 力然科噴射刷樹 【6666】

【従来の技術】気筒内に直接に燃料を噴射するインジェクタを備える直噴式エンジンにおいて、インジェクタを電磁式燃料噴射弁で構成し、インジェクタの開弁時間（噴射パルス幅）を運転状態に応じて0～100%の間でデューティ制御する燃料噴射量制御装置を備えるもの

がある。

【0003】従来の直噴式エンジンは、インジェクタに導かれる燃料圧力がプレッシャーレギュレータを介して大気圧との差圧が一定になるよう調節されている。

[0004]

【発明が解決しようとする課題】ところで、吸気管に燃料を噴射するインジェクタを備えた火花点火エンジンは、インジェクタに導かれる燃料圧力がプレッシャーレギュレータを介してインジェクタの背圧となる吸気管負圧との差圧が一定になるように調節されている。これにより、インジェクタの噴射率（単位時間当たりに噴射される燃料量）が一定に保たれ、インジェクタの開弁時間 $T_i$ を制御することにより、要求燃料量が得られる。

【0005】しかしながら、直噴式エンジンにおいて、インジェクタの背圧となる筒内圧は、燃料噴射が行われるクランク角や吸気管負圧に応じて変化するため、インジェクタの開弁時間 $T_i$ が同じでも、インジェクタの噴射率が増減し、要求燃料量が得られないという問題点がある。

【0006】これに対処して、特開平4-116243号公報に開示された直噴式エンジンの燃料噴射制御装置にあっては、筒内圧を検出するセンサを備え、検出された筒内圧を基にインジェクタの開弁時間 $T_i$ を補正するようになっている。

【0007】しかしながら、筒内圧センサを設けることにより構造の複雑化を招き、製品のコストアップを招くという問題点が考えられる。

【0008】本発明は上記の問題点を鑑みてなされたものであり、直噴式エンジンの燃料噴射制御装置において、筒内圧センサを用いることなく、燃料噴射量を正確に制御することを目的とする。

【0009】

【課題を解決するための手段】請求項1に記載の直噴式エンジンの燃料噴射制御装置は、図13に示すように、吸気通路を運転条件に応じて絞るスロットルバルブ101と、筒内に燃料を噴射するインジェクタ102と、検出された運転状態に応じてインジェクタ101の開弁時間 $T_i$ を制御する燃料噴射量制御手段103と、を備える直噴式エンジンの燃料噴射制御装置において、検出された運転状態に応じて筒内の圧力 $P_c$ を算出する筒内圧算出手段104と、算出された筒内圧 $P_c$ とインジェクタ101に供給される燃料圧力との差圧 $P_f$ を算出する差圧算出手段105と、算出された差圧 $P_f$ を基に燃料噴射率 $K$ を算出する燃料噴射率算出手段106と、算出された燃料噴射率 $K$ を基にインジェクタ101の開弁時間 $T_i$ を補正する燃料噴射量補正手段107と、を備える。

【0010】請求項2に記載の直噴式エンジンの燃料噴射制御装置は、請求項1に記載の発明において、クランク角を検出するクランク角検出手段と、検出されたクラ

ンク角とスロットルバルブより下流側に生じる吸気管負圧に応じて筒内の圧力 $P_c$ を算出する筒内圧算出手段と、を備える。

【0011】請求項3に記載の直噴式エンジンの燃料噴射制御装置は、請求項2に記載の発明において、吸入空気量を検出する吸入空気量検出手段と、吸気管の最小流路面積を検出する最小流路面積検出手段と、検出された吸入空気量と最小流路面積に応じてスロットルバルブより下流側に生じる吸気管負圧を算出する吸入負圧算出手段と、を備える。

【0012】請求項4に記載の直噴式エンジンの燃料噴射制御装置は、請求項1から3のいずれか一つに記載の発明において、エンジン回転速度から燃料噴射時期を決定する燃料噴射時期決定手段と、決定された燃料噴射時期とスロットルバルブより下流側に生じる吸気管負圧に応じて筒内の圧力 $P_c$ を算出する筒内圧算出手段と、を備える。

### 【0013】

【作用】請求項1に記載の直噴式エンジンの燃料噴射制御装置において、インジェクタ101の背圧である気筒内の圧力 $P_c$ がエンジンの運転状態に応じて変化するのに伴って、インジェクタ101の燃料噴射率が変化する。このため、インジェクタ101から1サイクルで気筒に噴射される燃料量は、インジェクタ101の開弁時間が同じでも気筒内の圧力 $P_c$ に応じて増減する。

【0014】本発明は、検出された運転状態に応じて筒内の圧力 $P_c$ を算出し、算出された筒内圧 $P_c$ とインジェクタ101に供給される燃料圧力との差圧 $P_f$ を算出し、算出された差圧 $P_f$ を基に燃料噴射率 $K$ を算出し、算出された燃料噴射率 $K$ を基にインジェクタ101の開弁時間 $T_i$ を補正するため、インジェクタ101の開弁時間を適確に補正することができる。したがって、従来装置のように筒内圧センサを設けることなく、製品のコストダウンがはかる。

【0015】請求項2に記載の直噴式エンジンの燃料噴射制御装置において、検出されたクランク角とスロットルバルブより下流側に生じる吸気管負圧に応じて筒内の圧力 $P_c$ を算出する。したがって、従来装置のように筒内圧センサを設けることなく、製品のコストダウンがはかる。

【0016】請求項3に記載の直噴式エンジンの燃料噴射制御装置において、検出された吸入空気量と最小流路面積に応じてスロットルバルブより下流側に生じる吸気管負圧を算出するため、吸気管負圧を検出するセンサを設けることなく、製品のコストダウンがはかる。

【0017】請求項4に記載の直噴式エンジンの燃料噴射制御装置において、決定された燃料噴射時期とスロットルバルブより下流側に生じる吸気管負圧に応じて筒内の圧力 $P_c$ を算出するため、インジェクタの開弁時間を適確に補正することができる。したがって、従来装置の

ように筒内圧センサを設けることなく、製品のコストダウンがはかる。

### 【0018】

【発明の実施の形態】以下、本発明の実施形態を添付図面に基づいて説明する。

【0019】図1に示すように、車両に搭載されるエンジン1は、吸気弁2が開かれるのに伴って吸気ポート3から気筒4に吸気を吸入すると同時に、インジェクタ14から気筒4内に直接燃料が噴射される。この吸気と噴射される燃料によって形成される混合気をピストン5で圧縮して、点火プラグ6で着火燃焼させ、排気弁7が開かれるのに伴って排気が排気ポート8を介して排気通路9に排出され、これらの各行程が連続して繰り返されるようになっている。

【0020】排気通路9の途中には三元触媒17、18がそれぞれ設置され、排気中のHC、COを酸化とともに、NOxを還元する。

【0021】吸入空気はエアクリーナ21から吸気ダクト22、スロットルチャンバー23を経て吸気管26および各吸入ポート3を通って各気筒4に吸入される。

【0022】スロットルチャンバー23には、アクセルペダルによって開閉駆動されるスロットルバルブ30が介装される。

【0023】吸気通路20のスロットルバルブ30より上流側と下流側を連通するバイパス通路35が配設される。バイパス通路35の途中には電磁式の補助空気弁(ISC)36が設けられる。

【0024】補助空気弁36はその開弁時間が0~100%の間でデューティ制御されるもので、スロットルバルブ30の閉時にエンジン運転状態に応じて吸入空気量を調節することにより、エンジン1のアイドル回転速度を目標値にフィードバック制御するようになっている。

【0025】図2に示すように、フューエルタンク59に貯留された燃料は、低圧燃料ポンプ58を介して吸い上げられ、高圧燃料ポンプ57に送られる。高圧燃料ポンプ57は、加圧した燃料を蓄圧室56へと送り、蓄圧室56から各気筒のインジェクタ14に燃料を圧送する。蓄圧室56の燃料圧力は図示しないプレッシャレギュレータを介して大気圧との差圧が所定値になるように調節される。高圧燃料ポンプ57から蓄圧室56に送られる余剰燃料は燃料戻し通路58を通ってフューエルタンク59へと戻される。

【0026】インジェクタ14は、その開弁時間が0~100%の間でデューティ制御されるもので、コントロールユニット13から送られるパルス信号によって開弁し、気筒4内に燃料を直接噴射する。インジェクタ14は吸気弁2が開弁して吸入ポート3から吸気が気筒4に流入する過程で開弁するように制御され、吸入空気と燃料の混合がはかる。

【0027】コントロールユニット13は、エアフロメ

ータ40で検出される吸気量Qと、スロットル開度センサ42で検出されるスロットル開度TVOと、エンジン回転速度センサ41で検出されるエンジン回転速度Neと、冷却水温センサ43で検出される冷却水温度Tw等を入力して、これら運転状態に応じてインジェクタ14の噴射噴射パルス幅Tiを制御する。

【0028】ところで、このような直噴タイプのインジェクタ14を備える燃料噴射装置にあっては、インジェクタ14の背圧である気筒内の圧力Pcがエンジン1の運転状態に応じて変化するのに伴って、インジェクタ14の燃料噴射率が変化する。このため、インジェクタ14から1サイクルで気筒4に噴射される燃料量は、インジェクタ14の開弁時間が同じでも気筒内の圧力Pcに応じて増減するという問題点がある。

【0029】本発明はこれに対処して、コントロールユニット13において、クランク角センサ10で検出されるクランク角θを入力し、クランク角θと吸気管26に

$$y = (S/2 + L) - \cos \theta - (L^2 - \sin^2 \theta)^{1/2} \quad \dots (1)$$

続いて、Step 3にて、次式に従いストローク量yにおける筒内容積Vを演算する。ただし、Vcylはシリンド行程容積、Vcombは燃焼室容積の長さである。

【0035】

$$V = V_{cyl} \times (y/S) + V_{comb} \quad \dots (2)$$

続いて、Step 4にて、次式に従い吸気管負圧Pと筒内容積Vから筒内圧Pcを演算する。ただし、Vivcは吸気弁2の閉時期における筒内容積、kは比熱比である。

$$[0036] P_c = (V_i v_c / V) \times P \quad \dots (3)$$

図4はクランク角θに対する筒内圧Pcの関係を示す。筒内圧Pcは、クランク角θがピストン下死点(BD C)からピストン上死点(TDC)に向かうのにしたがって次第に増大し、上死点付近で急激に立ち上がる特性がある。

【0037】続いて、Step 5にて、インジェクタ14に導かれる燃料圧力と筒内圧Pcとの差圧Pfを演算する。

【0038】続いて、Step 6にて、次式に従い噴射率Kを差圧Pfを基に演算する。ただし、KOは差圧POにおける噴射率である。

$$[0039] K = K_0 \times (P_f / P_0)^{1/2} \quad \dots (4)$$

図5は差圧POに対する噴射率Kの関係を示す。噴射率Kは、差圧Pfが増大するのにしたがって次第に増大する特性がある。

【0040】続いて、Step 7にて、次式に従い最終的な燃料パルス幅Tiを要求燃料量Tpと噴射率Kおよび無効噴射時間Tsを基に次式で演算する。

$$[0041] T_i = (T_p / K) + T_s \quad \dots (5)$$

ここで、要求燃料量Tpは別のルーチンで次式に従い演算される。ただし、Kpは定数、COEFは冷却水温度Tw等をパラメータとした各種補正係数の和である。

生じる負圧の平均値Pに基づいてインジェクタ14の燃料噴射率Kを算出し、インジェクタ14の開弁時間を補正する。

【0030】図3のフローチャートは、インジェクタ14の噴射パルス幅Tiを演算するプログラムを示しており、これは一定周期毎に実行される。

【0031】これについて説明すると、まず、Step 1にて、クランク角θと吸気管負圧平均値Pを入力する。

【0032】ここで、吸気管負圧平均値Pは、後述するように図6に示すルーチンで演算される。

【0033】続いて、Step 2にて、次式に従いクランク角θにおけるストローク量yを演算する。ただし、Sは総ストローク量、Lはコンロッド19の長さである。

【0034】

$$T_p = K_p \times Q / N_e \times COEF \quad \dots (6)$$

こうして演算された燃料噴射量Tiに対応するパルス信号を各インジェクタ14に出力し、燃料噴射制御を行う。

【0043】以上のようにクランク角センサ10で検出されるクランク角θと吸気管26に生じる負圧の平均値Pに基づいてインジェクタ14の燃料噴射率Kを算出し、インジェクタ14の開弁時間を適確に補正することができる。したがって、従来装置のように、筒内圧センサを設ける必要がなく、製品のコストダウンがはかれる。

【0044】図6のフローチャートは、吸気管負圧平均値Pを算出するルーチンを示しており、コントロールユニット13において一定周期毎に実行される。

【0045】これについて説明すると、まず、Step 1にて、クランク角θ、吸入空気量Q、冷却水温度Tw、スロットル開度α、補助空気弁36の開度β、エンジン回転速度Neを入力する。

【0046】続いて、Step 12にて、エンジン回転速度Neにより図7に示すテーブルに基づいて新気割合回転速度分母nを検索により求める。

【0047】続いて、Step 13にて、スロットル開度αにより図8に示すテーブルに基づいてスロットルバルブ30の開口面積を検索により求め、補助空気弁36の開度βにより図9に示すテーブルに基づいて補助空気弁36の開口面積を検索により求めるとともに、スロットルバルブ30の開口面積と補助空気弁36の開口面積の和として空気流路総面積AAを求める。

【0048】続いて、Step 14にて、エンジン回転速度Neと空気流路総面積AAを基に開度回転速度空気流量指數AADNVを次式で演算する。ただし、Veは

エンジンの総排気量である。

【0049】

$$AADNV = AA / (Ne \times Ve) \dots (7)$$

統いて、Step 15にて、開度回転速度空気流量指數 AADNVにより図10に示すテーブルに基づいて開度回転速度空気流量QH0を検索により求める。

【0050】統いて、Step 16にて、開度回転速度空気流量QH0により図11に示すテーブルに基づいて新氣割合流量nqを検索により求める。

【0051】統いて、Step 17にて、新氣割合回転速度分nと新氣割合流量nqを基に新氣割合nを次式で演算する。

$$n = n \times (1 - nq) + nq \dots (8)$$

統いて、吸入空気量Q、冷却水温度Tw、新氣割合nより吸入負圧Pを次式で算出する。ただし、Vcy1はシリンド行程容積、ρは空気密度である。

【0053】

$$P = (Q \times Tw) / (Vcy1 \times \rho \times n) \dots (9)$$

以上のように、検出されたエンジン運転状態に基づいて、吸気管負圧平均値Pを算出し、インジェクタ14の

$$y = (S/2 + L) - \cos \theta_{inj} - (L^2 - \sin^2 \theta_{inj})^{1/2} \dots (1)$$

統いて、Step 3にて、次式に従いストローク量yにおける筒内容積Vを演算する。ただし、Vcy1はシリンド行程容積、Vcombは燃焼室容積の長さである。

【0059】

$$V = Vcy1 \times (y/S) + Vcomb \dots (2)$$

統いて、Step 4にて、次式に従い吸気管負圧Pと筒内容積Vから筒内圧Pcを演算する。ただし、Vivcは吸気弁の閉時期における筒内容積、kは比熱比である。

$$Pc = (Vivc/V) \times P \dots (3)$$

統いて、Step 5にて、インジェクタに導かれる燃料圧力と筒内圧Pcとの差圧Pfを演算する。

【0061】統いて、Step 6にて、次式に従い噴射率Kを差圧Pfを基に演算する。ただし、KOは差圧POにおける噴射率である。

$$K = KO \times (Pf/PO)^{1/2} \dots (4)$$

統いて、Step 7にて、次式に従い最終的な燃料パルス幅Tiを要求燃料量Tpと噴射率Kおよび無効噴射時間Tsを基に次式で演算する。

$$Ti = (Tp/K) + Ts \dots (5)$$

この演算された燃料噴射量Tiに対応するパルス信号を各インジェクタに出力し、燃料噴射制御を行う。

【0064】以上のように決定された燃料噴射開始クラシク角θinjと吸気管に生じる負圧の平均値Pに基づいてインジェクタの燃料噴射率Kを算出し、インジェクタの開弁時間を適確に補正することができる。したがって、従来装置のように筒内圧センサを設けることなく、製品のコストダウンがはかれる。

【0065】

開弁時間を適確に補正することができる。したがって、吸気管負圧を検出するセンサを設けることなく、製品のコストダウンがはかれる。

【0054】次に、他の実施形態として、コントロールユニットにおいて、決定された燃料噴射開始クラシク角（燃料噴射時期）θinjと吸気管に生じる負圧の平均値Pに基づいてインジェクタの燃料噴射率Kを算出し、インジェクタの開弁時間を補正してもよい。

【0055】図12のフローチャートは、インジェクタの噴射パルス幅Tiを演算するプログラムを示しており、これは一定周期毎に実行される。なお、図3との対応部分には同一符号を付す。

【0056】これについて説明すると、まず、Step 1'にて、別のルーチンで決定された燃料噴射開始クラシク角θinjと吸気管負圧平均値Pを入力する。

【0057】統いて、Step 2'にて、次式に従い燃料噴射開始クラシク角θinjにおけるストローク量yを演算する。ただし、Sは総ストローク量、Lはコンロッドの長さである。

$$y = (S/2 + L) - \cos \theta_{inj} - (L^2 - \sin^2 \theta_{inj})^{1/2} \dots (1)$$

【発明の効果】以上説明したように請求項1に記載の直噴式エンジンの燃料噴射制御装置によれば、検出された運転状態に応じて筒内の圧力Pcを算出し、算出された筒内圧Pcとインジェクタに供給される燃料圧力との差圧Pfを算出し、算出された差圧Pfを基に燃料噴射率Kを算出し、算出された燃料噴射率Kを基にインジェクタの開弁時間Tiを補正するため、インジェクタの開弁時間を適確に補正することができる。したがって、従来装置のように筒内圧センサを設ける必要がなく、製品のコストダウンがはかれる。

【0066】請求項2に記載の直噴式エンジンの燃料噴射制御装置によれば、検出されたクラシク角とスロットルバルブより下流側に生じる吸気管負圧に応じて筒内の圧力Pcを算出するため、従来装置のように筒内圧センサを設けることなく、製品のコストダウンがはかれる。

【0067】請求項3に記載の直噴式エンジンの燃料噴射制御装置によれば、検出された吸入空気量と最小流路面積に応じてスロットルバルブより下流側に生じる吸気管負圧を算出するため、吸気管負圧を検出するセンサを設けることなく、製品のコストダウンがはかれる。

【0068】請求項4に記載の直噴式エンジンの燃料噴射制御装置によれば、決定された燃料噴射時期とスロットルバルブより下流側に生じる吸気管負圧に応じて筒内の圧力Pcを算出するため、従来装置のように筒内圧センサを設けることなく、製品のコストダウンがはかれる。

【図面の簡単な説明】

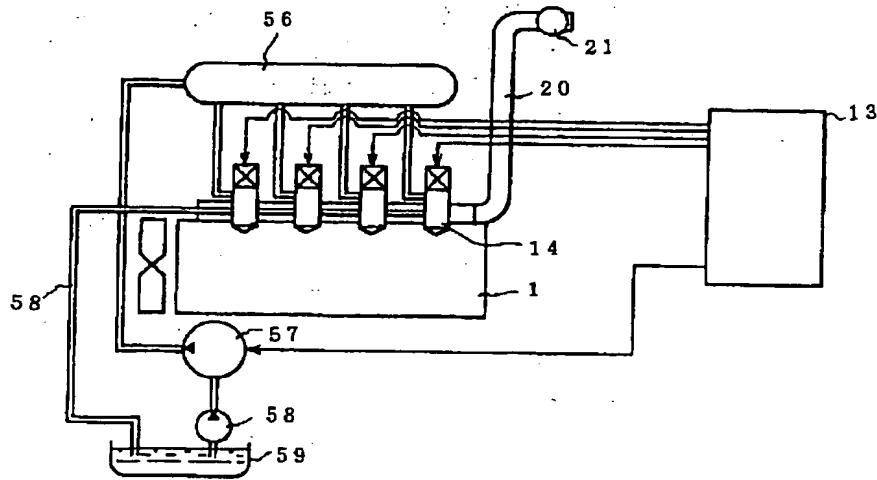
【図1】本発明の実施形態を示すエンジンのシステム図。

- 【図2】同じく燃料供給系のシステム図。
- 【図3】同じく燃料噴射パレス幅 $T_i$ を算出するフローチャート。
- 【図4】同じくクランク角 $\theta$ に対する筒内圧 $P_c$ の関係を示す特性図。
- 【図5】同じく差圧 $P_f$ に対する噴射率 $K$ の関係を示す特性図。
- 【図6】同じ吸入負圧平均値 $P$ を算出するフローチャート。
- 【図7】同じくエンジン回転速度 $N_e$ に対する新気割合回転速度分 $\eta_n$ の開度を示す特性図。
- 【図8】同じくスロットル開度 $\alpha$ に対するスロットル開口面積の開度を示す特性図。
- 【図9】同じく補助空気弁開度 $\beta$ に対する補助空気弁開口面積の関係を示す特性図。
- 【図10】同じく開度回転速度空気流量指数 $AAD_N$ に対する開度回転速度空気流量 $QHO$ の関係を示す特性図。
- 【図11】同じく開度回転速度空気流量 $QHO$ に対する新気割合流量 $\eta_q$ の関係を示す特性図。
- 【図12】他の実施形態を示す燃料噴射パレス幅 $T_i$ を算出するフローチャート。
- 【図13】請求項1に記載の発明を示すクレーム対応図。

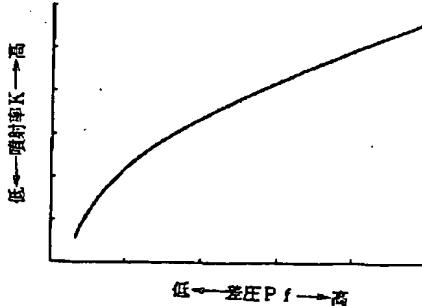
## 【符号の説明】

- 1 エンジン
- 2 吸気弁
- 4 気筒
- 5 ピストン
- 10 クランク角センサ
- 13 コントロールユニット
- 14 インジェクタ
- 20 吸気通路
- 26 吸気管
- 30 スロットルバルブ
- 31 コントロールバルブ
- 35 バイパス通路
- 36 補助空気弁
- 40 エアフローメータ
- 42 スロットル開度センサ
- 101 スロットルバルブ
- 102 インジェクタ
- 103 燃料噴射量制御手段
- 104 筒内圧算出手段
- 105 差圧算出手段
- 106 燃料噴射率算出手段
- 107 燃料噴射量補正手段

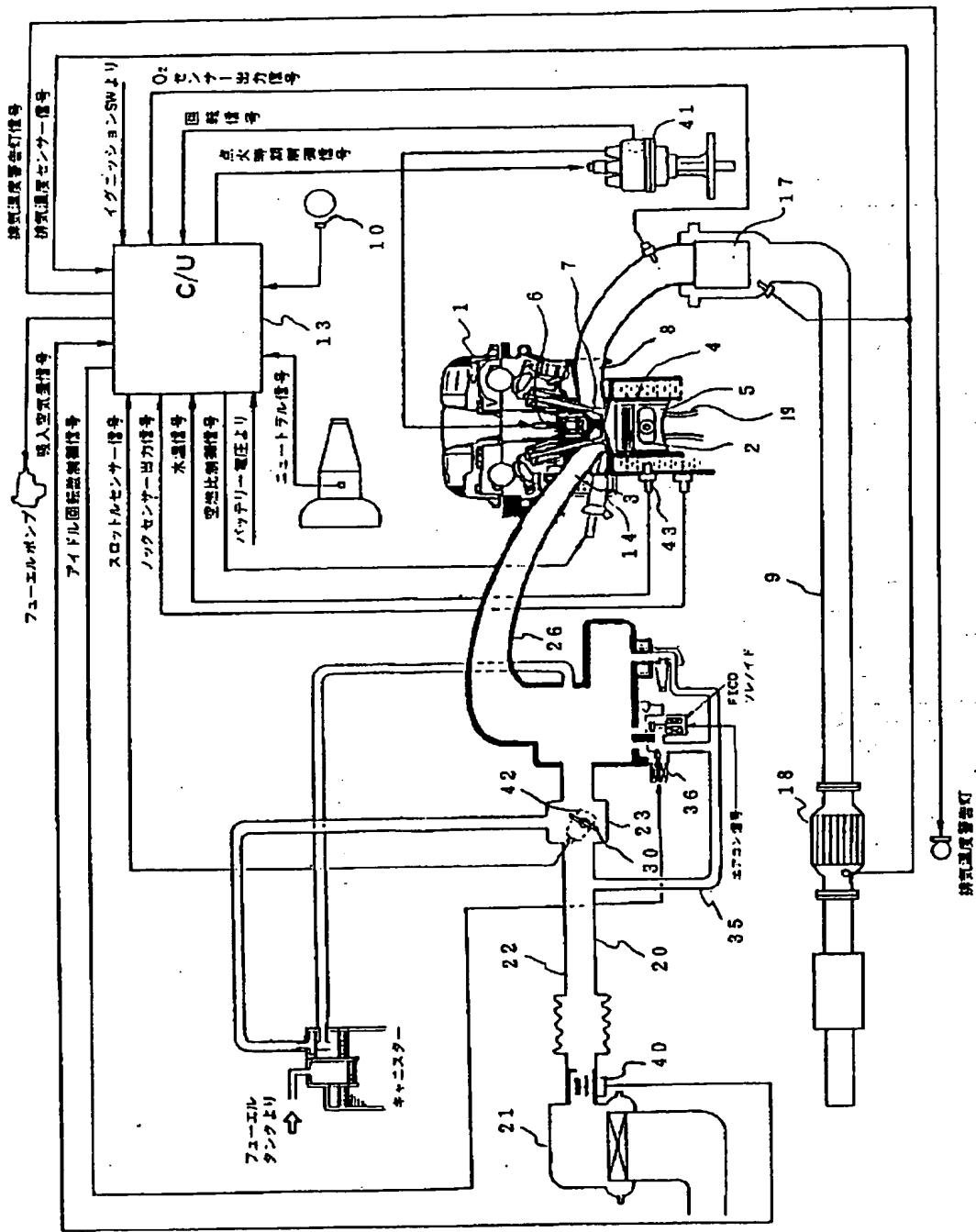
【図2】



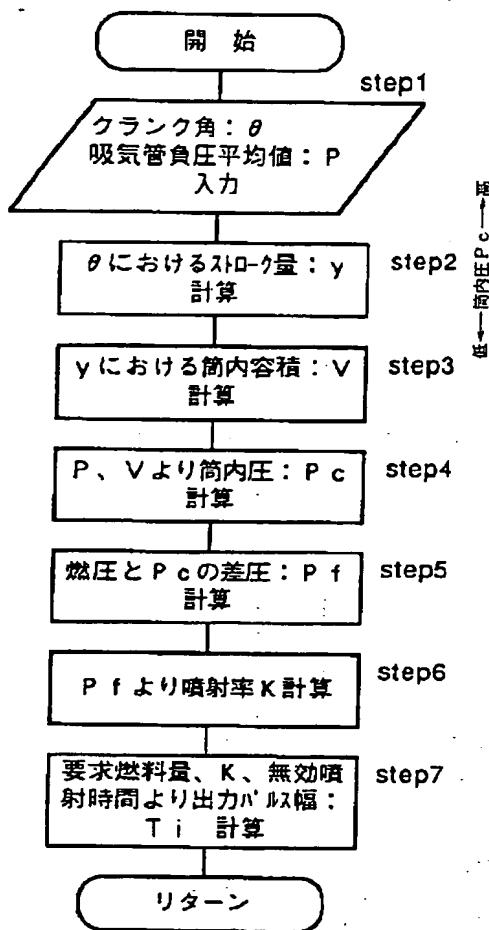
【図5】



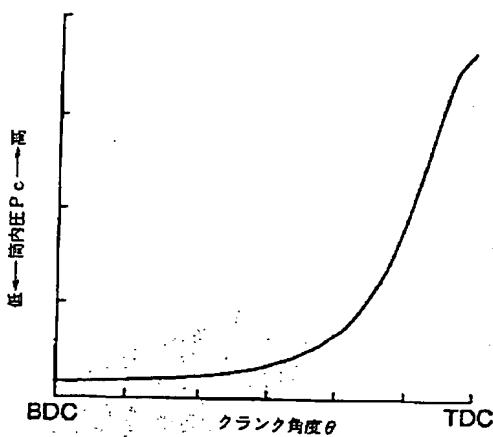
【図1】



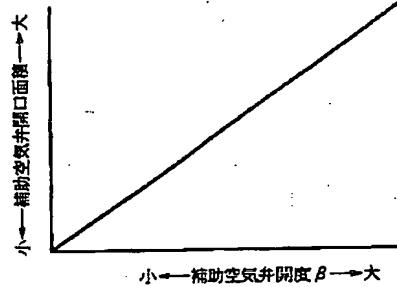
【図3】



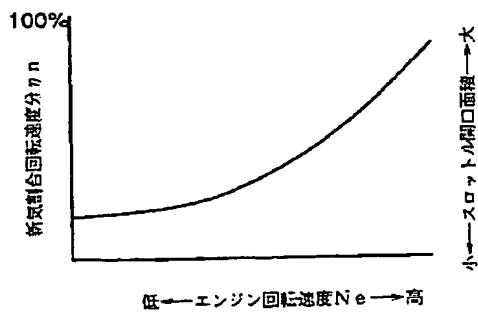
【図4】



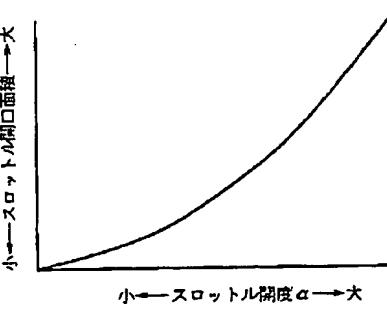
【図9】



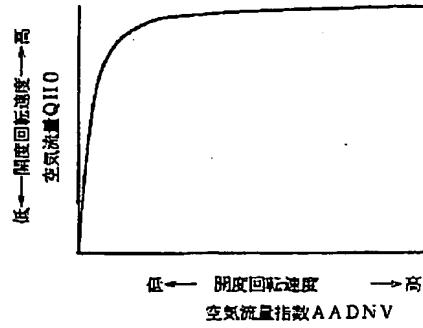
【図7】



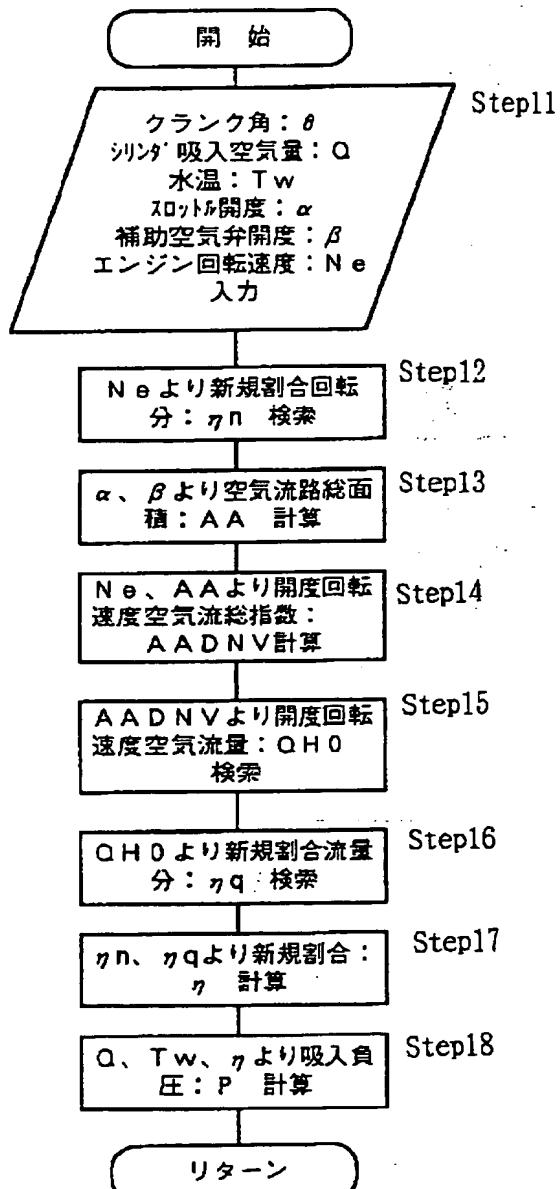
【図8】



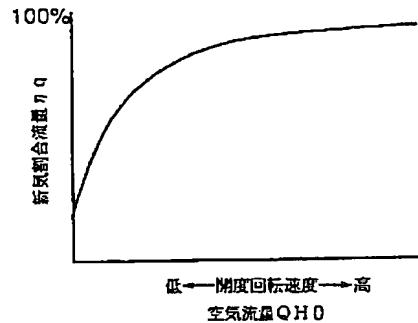
【図10】



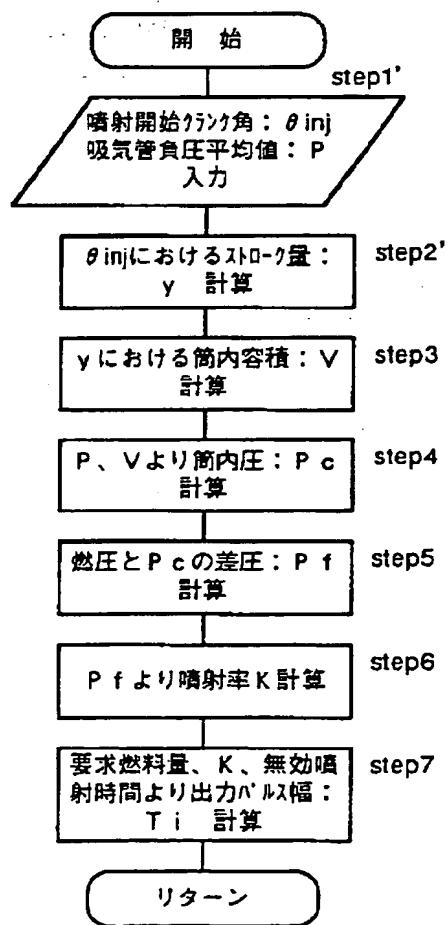
【図6】



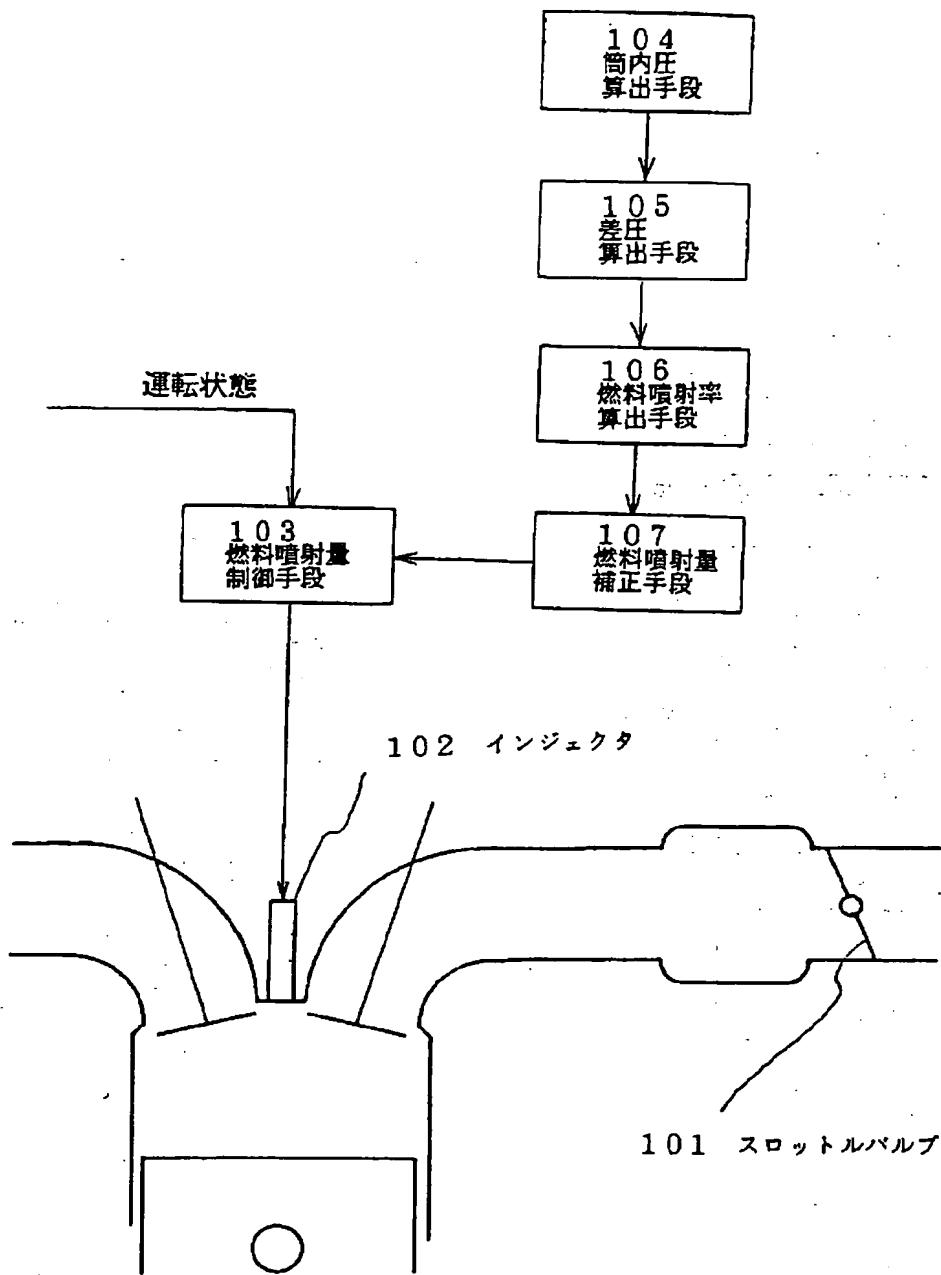
【図11】



【図12】



【図13】



フロントページの続き

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(71)Applicant : NISSAN MOTOR CO LTD

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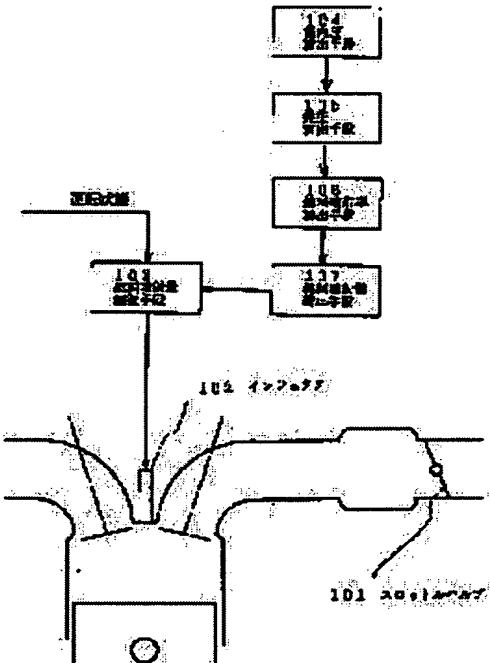
(72)Inventor : YASUOKA MASAYUKI

## (54) FUEL INJECTION CONTROLLER FOR DIRECT INJECTION TYPE ENGINE

## (57)Abstract:

**PROBLEM TO BE SOLVED:** To precisely control a fuel injection quantity by computing a differential pressure between a cylinder internal pressure computed according to an operating condition and a fuel pressure supplied to an injector, computing a fuel injection rate on the basis of the differential pressure, and correcting a valve opening time of the injector on the basis of the fuel injection rate.

**SOLUTION:** In a direct injection type engine provided with a throttle valve 101 throttling an intake passage in compliance with an operating condition and an injector 102 injecting fuel into a cylinder, a valve opening time of the injector 102 is controlled by means of a fuel injection quantity controlling means 103 according to the operating condition. The direct injection type engine is also provided with a cylinder internal pressure computing means 104, which computes a pressure inside the cylinder according to the operating condition, and a differential pressure between the computed cylinder internal pressure and a fuel pressure fed to the injector 102 is computed by means of the differential pressure computing means 105. On the basis of the computed differential pressure, a fuel injection rate is computed by means of a fuel injection rate computing means 106, and then, a valve opening time of the injector 102 is corrected by means of a fuel injection quantity correcting means 107 on the basis of the fuel injection rate.



## LEGAL STATUS

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[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of  
rejection]

[Date of extinction of right]

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CLAIMS

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## [Claim(s)]

[Claim 1] The throttle valve to which an inhalation-of-air path is extracted according to a service condition, and the injector which injects a fuel in a cylinder, In the fuel-injection control unit of a direct injection type engine equipped with the fuel-oil-consumption control means which controls the valve-opening time amount  $T_i$  of an injector according to the detected operational status A cylinder internal pressure calculation means to compute the pressure  $P_c$  in a cylinder according to the detected operational status, A differential pressure calculation means to compute the differential pressure  $P_f$  of the computed cylinder internal pressure  $P_c$  and the fuel pressure supplied to an injector, The fuel-injection control unit of the direct injection type engine characterized by having a rate calculation means of fuel injection to compute the rate  $K$  of fuel injection based on the computed differential pressure  $P_f$ , and a fuel-oil-consumption amendment means to amend the valve-opening time amount  $T_i$  of an injector based on the computed rate  $K$  of fuel injection.

[Claim 2] The fuel-injection control unit of the direct injection type engine according to claim 1 characterized by having a crank angle detection means to detect a crank angle, and the detected crank angle and a cylinder internal pressure calculation means to compute the pressure  $P_c$  in a cylinder according to the inlet-pipe negative pressure produced in the downstream from a throttle valve.

[Claim 3] The fuel-injection control unit of the direct injection type engine according to claim 2 characterized by having an inhalation air content detection means to detect an inhalation air content, a minimum flow-passage-area detection means to detect the minimum flow passage area of an inlet pipe, and the detected inhalation air content and an inhalation negative pressure calculation means to compute the inlet-pipe negative pressure produced in the downstream from a throttle valve according to the minimum flow passage area.

[Claim 4] The fuel-injection control unit of the direct injection type engine of any one publication of three from claim 1 characterized by having a fuel-injection-timing decision means to determine fuel injection timing from an engine speed, and the determined fuel injection timing and a cylinder internal pressure calculation means to compute the pressure  $P_c$  in a cylinder according to the inlet-pipe negative pressure produced in the downstream from a throttle valve.

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[Translation done.]

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to amelioration of the fuel-injection control unit of a direct injection type engine.

[0002]

[Description of the Prior Art] In the direct injection type engine equipped with the injector which injects a fuel directly in a gas column, there is a thing equipped with the fuel-oil-consumption control unit which constitutes an injector from an electromagnetic fuel injection valve, and carries out duty control of the valve-opening time amount (injection pulse width) of an injector among 0 - 100% according to operational status.

[0003] Through the pressure regulator, the fuel pressure with which the conventional direct injection type engine is led to an injector is adjusted for differential pressure with atmospheric pressure so that it may become fixed.

[0004]

[Problem(s) to be Solved by the Invention] By the way, the jump-spark-ignition engine which equipped the inlet pipe with the injector which injects a fuel is adjusted so that differential pressure with the inlet-pipe negative pressure from which the fuel pressure led to an injector serves as back pressure of an injector through a pressure regulator may become fixed. When the injection rate (fuel quantity injected by per unit time amount) of an injector is kept constant and controls the valve-opening time amount  $T_i$  of an injector by this, demand fuel quantity is obtained.

[0005] However, in a direct injection type engine, since the cylinder internal pressure used as the back pressure of an injector changes according to the crank angle and inlet-pipe negative pressure to which fuel injection is performed, but, the injection rate of an injector fluctuates and it has the trouble that the valve-opening time amount  $T_i$  of an injector is the same and that demand fuel quantity is not obtained.

[0006] This is coped with, if it is in the fuel-injection control device of the direct injection type engine indicated by JP,4-116243,A, it has the sensor which detects cylinder internal pressure, and the valve-opening time amount  $T_i$  of an injector is amended based on the detected cylinder internal pressure.

[0007] However, the trouble of causing complication of structure and causing the cost rise of a product can be considered by forming a cylinder internal pressure sensor.

[0008] This invention is made in view of the above-mentioned trouble, and it aims at controlling fuel oil consumption correctly, without using a cylinder internal pressure sensor in the fuel-injection control unit of a direct injection type engine.

[0009]

[Means for Solving the Problem] The fuel-injection control unit of a direct injection type engine according to claim 1 The throttle valve 101 to which an inhalation-of-air path is extracted according to a service condition as shown in drawing 13 , In the fuel-injection control unit of a direct injection type engine equipped with the injector 102 which injects a fuel in a cylinder, and the fuel-oil-consumption control means 103 which controls the valve-opening time amount  $T_i$  of an injector 101 according to the detected operational status A cylinder internal pressure calculation means 104 to compute the pressure  $P_c$  in a cylinder according to the detected operational status, A differential pressure calculation means 105 to compute the differential pressure  $P_f$  of the computed cylinder internal pressure  $P_c$  and the fuel pressure supplied to an injector 101, It has a rate calculation means 106 of fuel injection to compute the rate  $K$  of fuel injection based on the computed differential pressure  $P_f$ , and a fuel-oil-consumption amendment means 107 to amend the valve-opening time amount  $T_i$  of an injector 101 based on the computed rate  $K$  of fuel injection.

[0010] The fuel-injection control unit of a direct injection type engine according to claim 2 is equipped with a crank angle detection means to detect a crank angle, and the detected crank angle and a cylinder internal pressure calculation means to compute the pressure  $P_c$  in a cylinder according to the inlet-pipe negative pressure produced in the downstream from a throttle valve, in invention according to claim 1.

[0011] The fuel-injection control unit of a direct injection type engine according to claim 3 is equipped with an inhalation air content detection means to detect an inhalation air content, a minimum flow-passage-area detection means to detect the minimum flow passage area of an inlet pipe, and the detected inhalation air content and an inhalation negative pressure calculation means to compute the inlet-pipe negative pressure produced in the downstream from a throttle valve according to the minimum flow passage area, in invention according to claim 2.

[0012] The fuel-injection control device of a direct injection type engine according to claim 4 is equipped with a fuel-injection-timing decision means to determine an engine speed to fuel injection timing in invention of any one publication of three, and the determined fuel injection timing and a cylinder internal pressure calculation means to compute the pressure  $P_c$  in a cylinder according to the inlet-pipe negative pressure produced in the downstream from a throttle valve, from claim 1.

[0013]

[Function] In the fuel-injection control device of a direct injection type engine according to claim 1, the rate of fuel injection of an injector 101 changes in connection with the pressure  $P_c$  in the gas column which is the back pressure of an injector 101 changing according to engine operational status. for this reason, the fuel quantity injected by the gas column in 1 cycle from an injector 101 is fluctuated according to the pressure  $P_c$  in a gas column, even when the valve-opening time amount of an injector 101 is the same.

[0014] This invention computes the pressure  $P_c$  in a cylinder according to the detected operational status, and since it computes the differential pressure  $P_f$  of the computed cylinder internal pressure  $P_c$  and the fuel pressure supplied to an injector 101, computes the rate  $K$  of fuel injection based on the computed differential pressure  $P_f$  and amends the valve-opening time amount  $T_i$  of an injector 101 based on the computed rate  $K$  of fuel injection, it can amend the valve-opening time amount of an injector 101 accurately. Therefore, the cost cut of a product can be aimed at, without forming a cylinder internal pressure sensor like equipment before.

[0015] In the fuel-injection control device of a direct injection type engine according to claim 2, the pressure  $P_c$  in a cylinder is computed according to the inlet-pipe negative pressure produced in the downstream from the detected crank angle and a throttle valve. Therefore, the cost cut of a product can be aimed at, without forming a cylinder internal pressure sensor like equipment before.

[0016] The cost cut of a product can be aimed at in the fuel-injection control device of a direct injection type engine according to claim 3, without forming the sensor which detects inlet-pipe negative pressure, in order to compute the inlet-pipe negative pressure produced in the downstream from a throttle valve according to the inhalation air content and the minimum flow passage area which were detected.

[0017] In the fuel-injection control device of a direct injection type engine according to claim 4, since the pressure  $P_c$  in a cylinder is computed according to the inlet-pipe negative pressure produced in the downstream from the determined fuel injection timing and a throttle valve, the valve-opening time amount of an injector can be amended accurately. Therefore, the cost cut of a product can be aimed at, without forming a cylinder internal pressure sensor like equipment before.

[0018]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained based on an accompanying drawing.

[0019] As shown in drawing 1, a direct fuel is injected in a gas column 4 from an injector 14 at the same time the engine 1 carried in a car inhales inhalation of air in a gas column 4 from a suction port 3 in connection with an inlet valve 2 being opened. This inhalation of air and the gaseous mixture formed with the fuel injected are compressed at a piston 5, ignition combustion is carried out with an ignition plug 6, exhaust air is discharged by the flueway 9 through the exhaust air port 8 in connection with an exhaust valve 7 being opened, and each of these strokes are repeated continuously.

[0020] NOx is returned, while three way component catalysts 17 and 18 are installed, respectively and oxidize HC under exhaust air, and CO in the middle of a flueway 9.

[0021] Inhalation air is inhaled by each gas column 4 through an inlet pipe 26 and each inhalation port 3 through an air intake duct 22 and the throttle chamber 23 from an air cleaner 21.

[0022] The throttle valve 30 by which a closing motion drive is carried out with an accelerator pedal is infixed in the throttle chamber 23.

[0023] The bypass path 35 which opens the upstream and the downstream for free passage from the throttle valve 30 of the inhalation-of-air path 20 is arranged. The electromagnetic compensating air valve (ISC) 36 is formed in the middle of the bypass path 35.

[0024] Duty control of the valve-opening time amount is carried out among 0 - 100%, and a compensating air valve 36 carries out feedback control of the idle rotational speed of an engine 1 to desired value by adjusting an inhalation air content according to an engine operation condition at the time of close [ of a throttle valve 30 ].

[0025] As shown in drawing 2, the fuel stored by the fuel tank 59 is sucked up through the low voltage fuel pump 58, and is sent to the high-pressure fuel pump 57. The high-pressure fuel pump 57 feeds a fuel for the pressurized fuel from delivery and an accumulator 56 to the injector 14 of each gas column to an accumulator 56. The fuel pressure of an accumulator 56 is adjusted so that differential pressure with atmospheric pressure may become a predetermined value through the pressure regulator which is not illustrated. The surplus fuel sent to an accumulator 56 is returned to the fuel tank 59 through the fuel return path 58 from the high-pressure fuel pump 57.

[0026] Duty control of the valve-opening time amount is carried out among 0 - 100%, and an injector 14 opens by the pulse signal sent from a control unit 13, and injects a fuel directly into a gas column 4. An injector 14 is controlled to open in the process in which an inlet valve 2 opens and inhalation of air flows into a gas column 4 from the inhalation port 3, and mixing of inhalation air and a fuel is aimed at.

[0027] A control unit 13 inputs the inspired air volume  $Q$  detected with an air flow meter 40, the throttle opening TVO detected by the throttle opening sensor 42, the engine speed  $N_e$  detected by the engine-speed sensor 41, the circulating water temperature  $T_w$  detected with the cooling coolant temperature sensor 43, and controls injection injection pulse width  $T_i$  of an injector 14 according to these operational status.

[0028] By the way, if it is in a fuel injection equipment equipped with the such direct injection type injector 14, in connection with the pressure  $P_c$  in the gas column which is the back pressure of an injector 14 changing according to the operational status of an engine 1, the rate of fuel injection of an injector 14 changes. For this reason, the fuel quantity injected by the gas column 4 in 1 cycle from an injector 14 has the trouble that the valve-opening time amount of an injector 14 is the same and of fluctuating according to the pressure  $P_c$  in a gas column but.

[0029] This invention copes with this, inputs crank angle theta detected by the crank angle sensor 10 in a control unit 13, computes the rate  $K$  of fuel injection of an injector 14 based on the average value  $P$  of the negative pressure produced in crank angle theta and an inlet pipe 26, and amends the valve-opening time amount of an injector 14.

[0030] The flow chart of drawing 3 shows the program which calculates injection pulse width  $T_i$  of an injector 14, and this is performed for every fixed period.

[0031] Explanation of this inputs crank angle theta and the inlet-pipe negative pressure average  $P$  by Step1 first.

[0032] Here, the inlet-pipe negative pressure average value  $P$  is calculated by the routine it is indicated to drawing 6 that mentions later.

[0033] Then, according to a degree type, the amount  $y$  of strokes in crank angle theta is calculated by Step2. However,  $S$  is the total amount of strokes and  $L$  is the die length of a connecting rod 19.

[0034]

$$y = (S/2 + L) - \text{costheta} - (L \cdot \sin^2 \theta) / 2 \quad (1)$$

Then, according to a degree type, the cylinder content volume  $V$  in the amount  $y$  of strokes is calculated by Step3. However,  $V_{cyl}$  is cylinder cylinder capacity and  $V_{comb}$  is the die length of volume of combustion chamber.

[0035]

$$V = V_{cyl}x(y/S) + V_{comb} \quad (2)$$

Then, according to a degree type, the cylinder internal pressure  $P_c$  is calculated from the inlet-pipe negative pressure  $P$  and the cylinder content volume  $V$  by Step4. However, cylinder content volume [ in  $V_{cyl}$  / in  $V_{comb}$  / the closed stage of an inlet valve 2 ] and  $k$  are the ratio of specific heat.

$$P_c = (V_{cyl}/V) \times P \quad (3)$$

Drawing 4 shows the relation of the cylinder internal pressure  $P_c$  to crank angle theta. Crank angle theta increases gradually according to going to a piston top dead center (TDC) from a piston bottom dead point (BDC), and the cylinder internal pressure  $P_c$  has the property of starting rapidly near a top dead center.

[0037] Then, the differential pressure  $P_f$  of the fuel pressure and the cylinder internal pressure  $P_c$  which are led to an injector 14 by Step5 is calculated.

[0038] Then, according to a degree type, an injection rate K is calculated based on differential pressure Pf by Step6. However, K0 is an injection rate in differential pressure P0.

[0039]  $K=K0x(Pf/P0) 1/2 - (4)$

Drawing 5 shows the relation of the injection rate K over differential pressure P0. An injection rate K has the property which increases gradually according to differential pressure Pf increasing.

[0040] Then, according to a degree type, final fuel pulse width Ti is calculated by the degree type by Step7 based on the demand fuel quantity Tp, an injection rate K, and the invalid injection time Ts.

[0041]  $Ti=(Tp/K)+Ts - (5)$

Here, the demand fuel quantity Tp is calculated according to a degree type by another routine. However, it is the sum of the various correction factors which Kp made the circulating water temperature Tw etc. as the constant, and COEF made the parameter.

[0042]

$Tp=KpxQ/NexCOEF - (6)$

In this way, the pulse signal corresponding to the calculated fuel oil consumption Ti is outputted to each injector 14, and fuel-injection control is performed.

[0043] Based on the average value P of the negative pressure produced in crank angle theta detected by the crank angle sensor 10 as mentioned above, and an inlet pipe 26, the rate K of fuel injection of an injector 14 can be computed, and the valve-opening time amount of an injector 14 can be amended accurately. Therefore, it is not necessary to form a cylinder internal pressure sensor in equipment like conventionally, and the cost cut of a product can be aimed at.

[0044] The flow chart of drawing 6 shows the routine which computes the inlet-pipe negative pressure average value P, and is performed for every fixed period in a control unit 13.

[0045] Explanation of this first inputs crank angle theta, the inhalation air content Q, a circulating water temperature Tw, the throttle opening alpha, the opening beta of a compensating air valve 36, and an engine speed Ne by Step11.

[0046] Then, based on the table shown in drawing 7 by the engine speed Ne, it asks for new mind rate rotational-speed part etan by retrieval by Step12.

[0047] Then, while asking for the opening area of a throttle valve 30 by retrieval based on the table shown in drawing 8 by the throttle opening alpha and asking for the opening area of a compensating air valve 36 by retrieval by Step13 based on the table shown in drawing 9 by the opening beta of a compensating air valve 36, it asks for the airstream way gross area AA as the sum of the opening area of a throttle valve 30, and the opening area of a compensating air valve 36.

[0048] Then, the opening rotational-speed air-flow-rate characteristic AADNV is calculated by the degree type based on an engine speed Ne and the airstream way gross area AA by Step14. However, Ve is engine total cubic displacement.

[0049]

$AADNV=AA/(NexVe) - (7)$

Then, based on the table shown in drawing 10 with the opening rotational-speed air-flow-rate characteristic AADNV, it asks for the opening rotational-speed air flow Q H0 by retrieval by Step15.

[0050] Then, based on the table shown in drawing 11 by the opening rotational-speed air flow Q H0, it asks for new mind rate flow rate etaq by retrieval by Step16.

[0051] Then, the new mind rate eta is calculated by the degree type by Step17 based on new mind rate rotational-speed part etan and new mind rate flow rate etaq.

[0052]  $Eta=etanx(1-etaq) +etaq - (8)$

Then, the inhalation negative pressure P is computed by the degree type from the inhalation air content Q, a circulating water temperature Tw, and the new mind rate eta. However, Vcyl is cylinder cylinder capacity and rho is air density.

[0053]

$P=(QxTw) / (Vcylxrhoxeta) - (9)$

As mentioned above, based on the detected engine operation condition, the inlet-pipe negative pressure average value P can be computed, and the valve-opening time amount of an injector 14 can be amended accurately. Therefore, the cost cut of a product can be aimed at, without forming the sensor which detects inlet-pipe negative pressure.

[0054] Next, in a control unit, the rate K of fuel injection of an injector may be computed as other operation gestalten based on the average value P of the negative pressure produced in determined fuel-injection initiation crank angle (fuel injection timing) theta inj and an inlet pipe, and the valve-opening time amount of an injector may be amended.

[0055] The flow chart of drawing 12 shows the program which calculates injection pulse width Ti of an injector, and this is performed for every fixed period. In addition, the same sign is given to a corresponding point with drawing 3.

[0056] Explanation of this inputs fuel-injection initiation crank angle theta in j and the inlet-pipe negative pressure average P which were first determined by another routine at Step1'.

[0057] Then, according to a degree type, the amount y of strokes in fuel-injection initiation crank angle theta in j is calculated in Step2'. However, S is the total amount of strokes and L is the die length of a connecting rod.

[0058]

$y=(S/2+L)-costhetainj-(L2-sin2thetainj) 1/2 - (1)$

Then, according to a degree type, the cylinder content volume V in the amount y of strokes is calculated by Step3. However, Vcyl is cylinder cylinder capacity and Vcomb is the die length of volume of combustion chamber.

[0059]

$V=Vcylx(y/S)+Vcomb - (2)$

Then, according to a degree type, the cylinder internal pressure Pc is calculated from the inlet-pipe negative pressure P and the cylinder content volume V by Step4. However, cylinder content volume [ in / in Vivc / the closed stage of an inlet valve ] and k are the ratio of specific beat.

[0060]  $Pc=(Vivc/V) xP - (3)$

Then, the differential pressure Pf of the fuel pressure and the cylinder internal pressure Pc which are led to an injector by Step5 is calculated.

[0061] Then, according to a degree type, an injection rate K is calculated based on differential pressure Pf by Step6. However, K0 is an injection rate in differential pressure P0.

[0062]  $K=K0x(Pf/P0) 1/2 - (4)$

Then, according to a degree type, final fuel pulse width Ti is calculated by the degree type by Step7 based on the demand fuel quantity Tp, an injection rate K, and the invalid injection time Ts.

[0063]  $Ti=(Tp/K)+Ts - (5)$

The pulse signal corresponding to this calculated fuel oil consumption  $T_i$  is outputted to each injector, and fuel-injection control is performed.

[0064] Based on the average value  $P$  of the negative pressure produced in fuel-injection initiation crank angle  $\theta_{inj}$  determined as mentioned above and an inlet pipe, the rate  $K$  of fuel injection of an injector can be computed, and the valve-opening time amount of an injector can be amended accurately. Therefore, the cost cut of a product can be aimed at, without forming a cylinder internal pressure sensor like equipment before.

[0065]

-[Effect of the Invention] As explained above, according to the fuel-injection control unit of a direct injection type engine according to claim 1 According to the detected operational status, compute the pressure  $P_c$  in a cylinder, and the differential pressure  $P_f$  of the computed cylinder internal pressure  $P_c$  and the fuel pressure supplied to an injector is computed. The rate  $K$  of fuel injection is computed based on the computed differential pressure  $P_f$ , and since the valve-opening time amount  $T_i$  of an injector is amended based on the computed rate  $K$  of fuel injection, the valve-opening time amount of an injector can be amended accurately. Therefore, it is not necessary to form a cylinder internal pressure sensor like equipment before, and the cost cut of a product can be aimed at.

[0066] The cost cut of a product can be aimed at without forming a cylinder internal pressure sensor like conventional equipment, in order to compute the pressure  $P_c$  in a cylinder according to the inlet-pipe negative pressure produced in the downstream from the detected crank angle and a throttle valve according to the fuel-injection control device of a direct injection type engine according to claim 2.

[0067] The cost cut of a product can be aimed at without forming the sensor which detects inlet-pipe negative pressure, in order to compute the inlet-pipe negative pressure produced in the downstream from a throttle valve according to the inhalation air content and the minimum flow passage area which were detected according to the fuel-injection control device of a direct injection type engine according to claim 3.

[0068] The cost cut of a product can be aimed at without forming a cylinder internal pressure sensor like conventional equipment, in order to compute the pressure  $P_c$  in a cylinder according to the inlet-pipe negative pressure produced in the downstream from the determined fuel injection timing and a throttle valve according to the fuel-injection control device of a direct injection type engine according to claim 4.

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[Translation done.]

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## DESCRIPTION OF DRAWINGS

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**[Brief Description of the Drawings]**

- [Drawing 1] The system chart of the engine in which the operation gestalt of this invention is shown.  
[Drawing 2] Similarly it is the system chart of a fuel-supply system.  
[Drawing 3] The flow chart which similarly computes fuel-injection pulse width Ti.  
[Drawing 4] The property Fig. showing the relation of the cylinder internal pressure Pc to crank angle theta similarly.  
[Drawing 5] The property Fig. showing the relation of the injection rate K over differential pressure Pf similarly.  
[Drawing 6] The flow chart which computes the same inhalation negative pressure average value P.  
[Drawing 7] The property Fig. showing the opening of new mind rate rotational-speed part etan to an engine speed Ne similarly.  
[Drawing 8] The property Fig. showing the opening of throttle opening area to the throttle opening alpha similarly.  
[Drawing 9] The property Fig. showing the relation of the supplementary air valve-opening opening area to beta whenever [supplementary air valve-opening ] similarly.  
[Drawing 10] The property Fig. showing the relation of the opening rotational-speed air flow Q H0 to the opening rotational-speed air-flow-rate characteristic AADN similarly.  
[Drawing 11] The property Fig. showing the relation of new mind rate flow rate etaq to the opening rotational-speed air flow Q H0 similarly.  
[Drawing 12] The flow chart which computes fuel-injection pulse width Ti which shows other operation gestalten.  
[Drawing 13] The Fig. corresponding to a claim showing invention according to claim 1.

**[Description of Notations]**

- 1 Engine
- 2 Inlet Valve
- 4 Gas Column
- 5 Piston
- 10 Crank Angle Sensor
- 13 Control Unit
- 14 Injector
- 20 Inhalation-of-Air Path
- 26 Inlet Pipe
- 30 Throttle Valve
- 31 Control Valve
- 35 Bypass Path
- 36 Compensating Air Valve
- 40 Air Flow Meter
- 42 Throttle Opening Sensor
- 101 Throttle Valve
- 102 Injector
- 103 Fuel-Oil-Consumption Control Means
- 104 Cylinder Internal Pressure Calculation Means
- 105 Differential Pressure Calculation Means
- 106 Rate Calculation Means of Fuel Injection
- 107 Fuel-Oil-Consumption Amendment Means

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[Translation done.]

## \* NOTICES \*

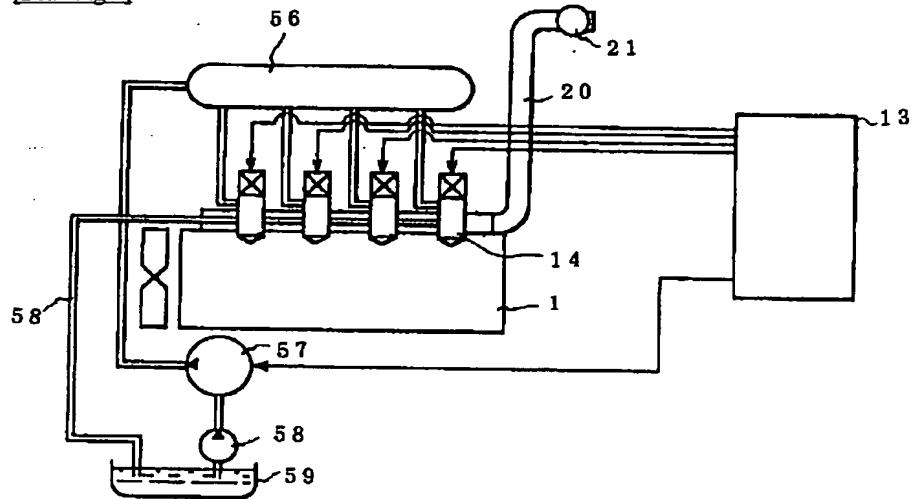
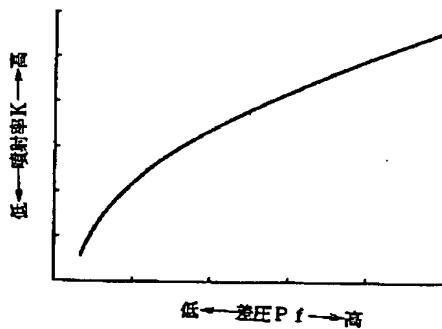
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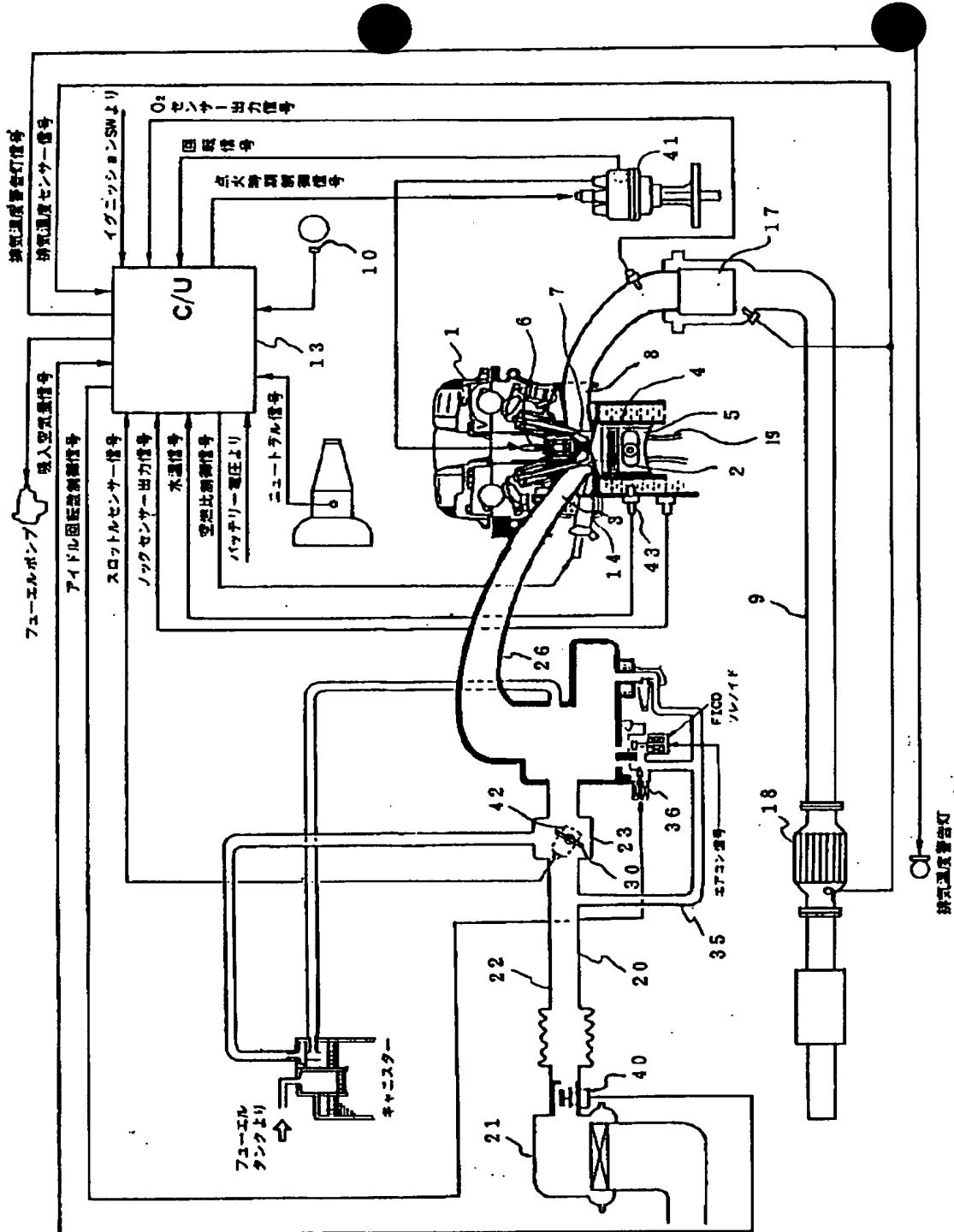
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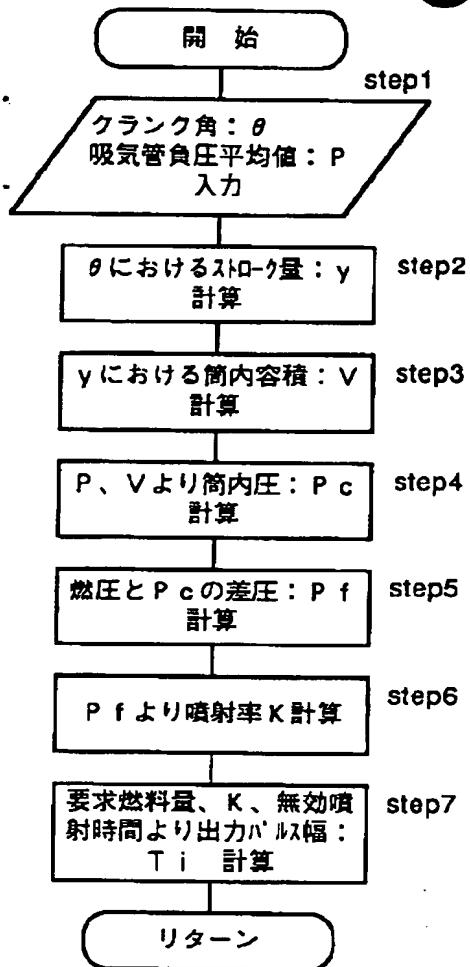
**DRAWINGS**

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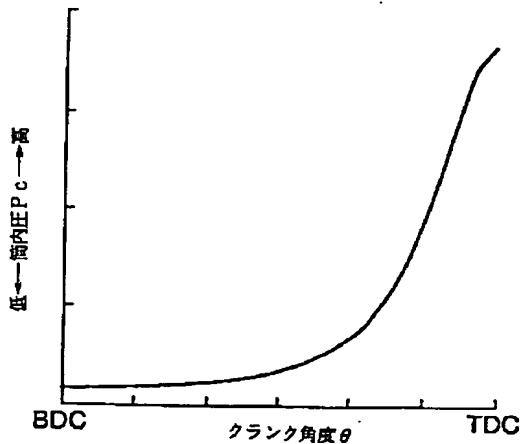
**[Drawing 2]****[Drawing 5]****[Drawing 1]**



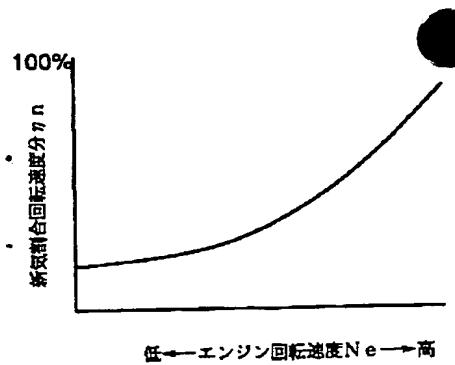
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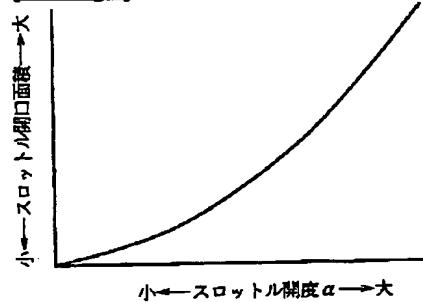
[Drawing 4]



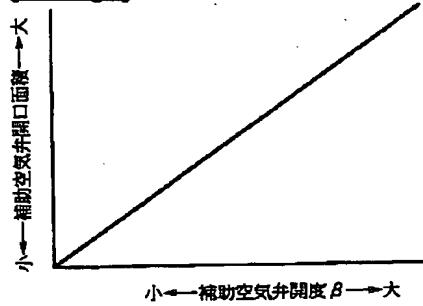
[Drawing 7]



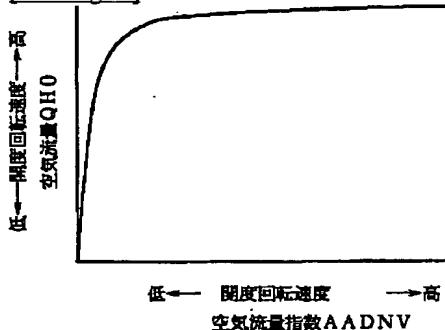
[Drawing 8]



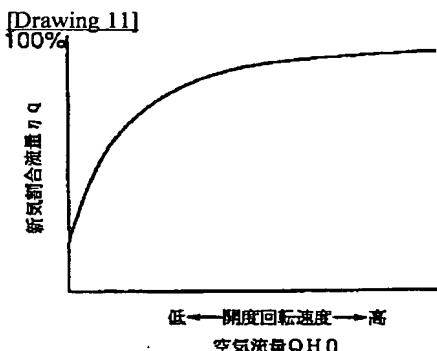
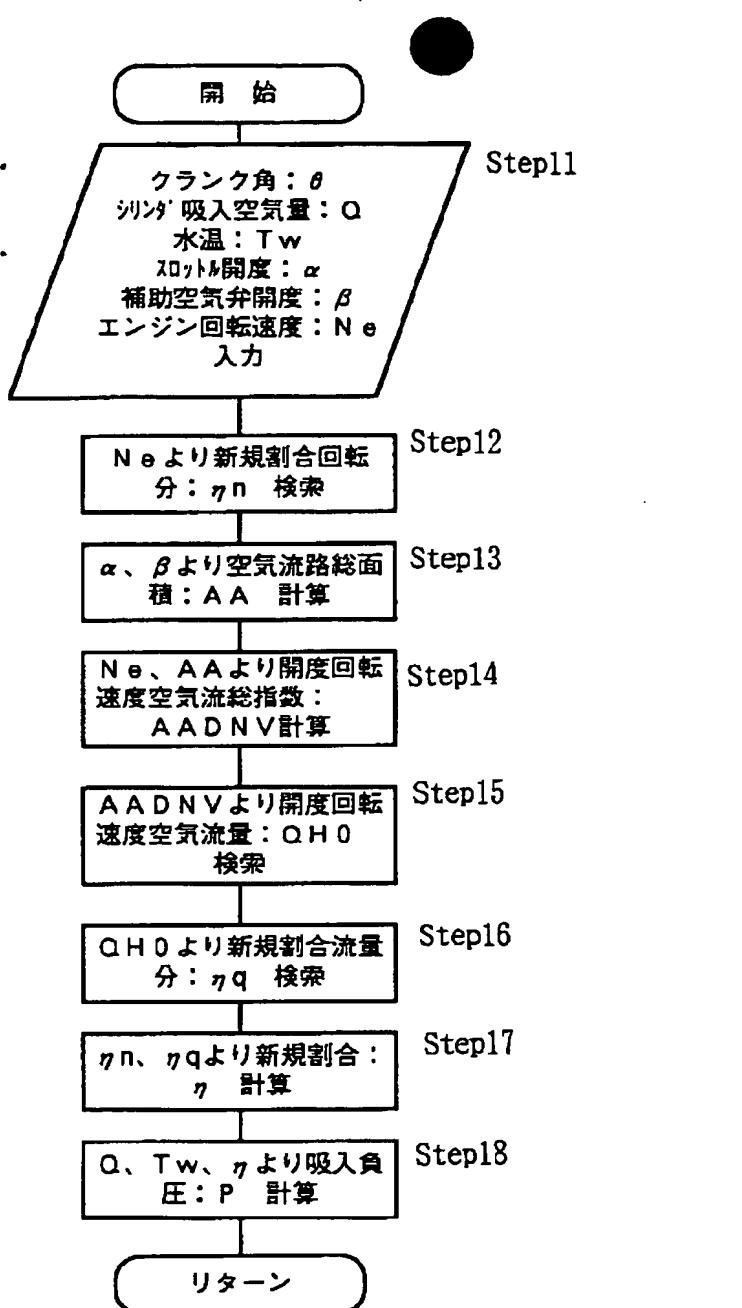
[Drawing 9]



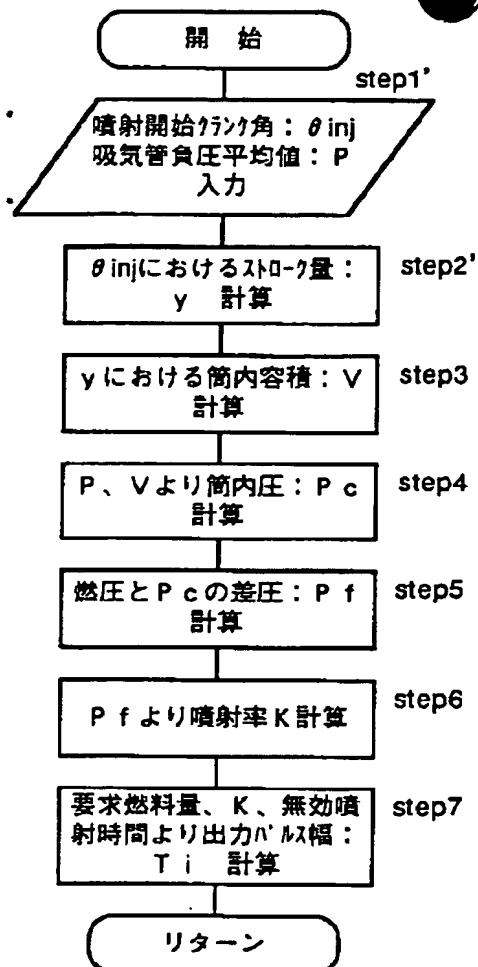
[Drawing 10]



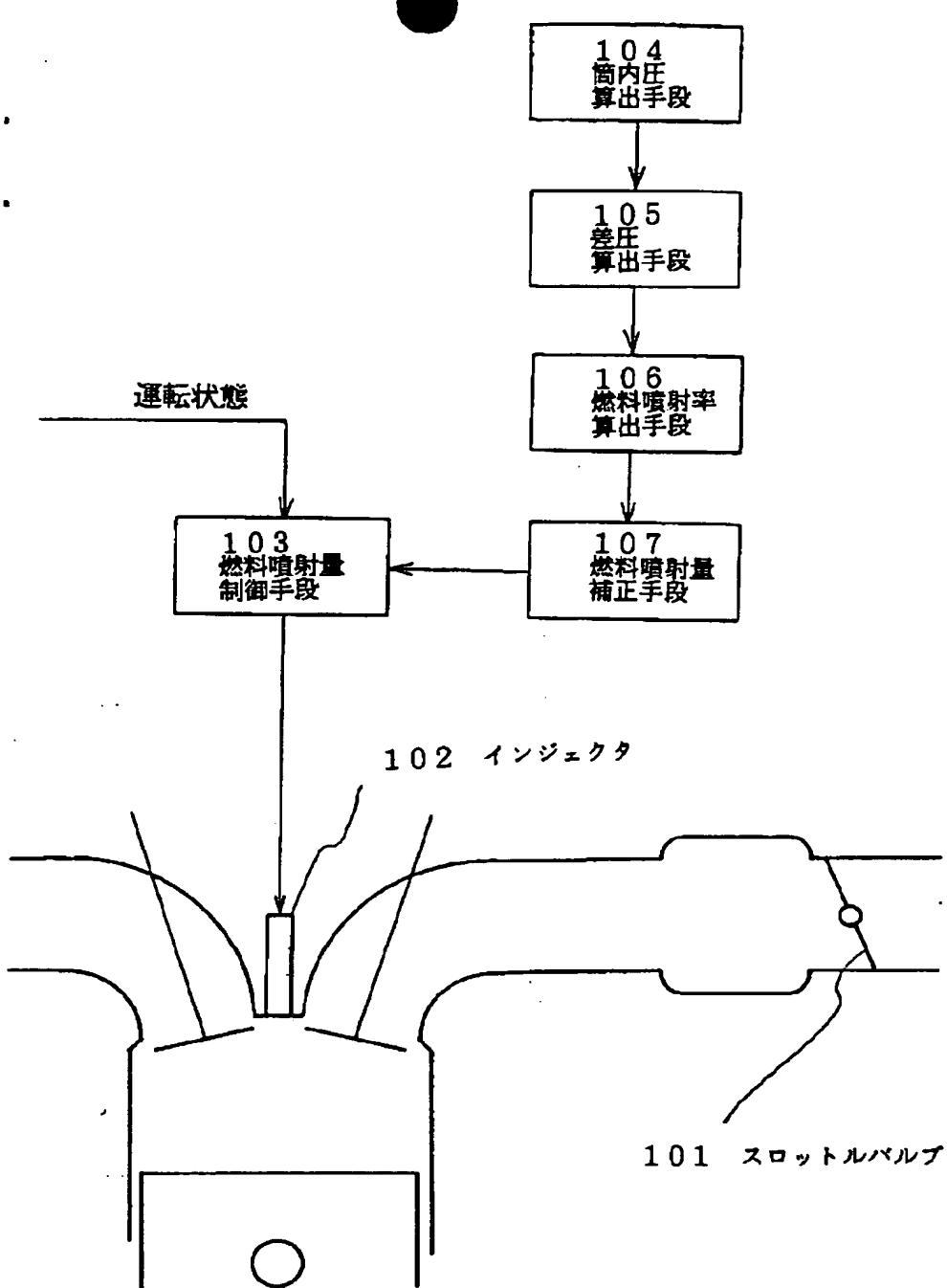
[Drawing 6]



[Drawing 12]



[Drawing 13]



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